Introduction

This chapter focuses on several key issues at the heart of the current debate over the quality of our elementary and secondary mathematics and science education system. Trends in math and science achievement and coursetaking are examined first, both as system outputs and as the context for current reform efforts. Next, the chapter examines several quantifiable aspects of current reform efforts. Maintaining the science and engineering (S&E) pipeline and preparing all young people for an increasingly technological society are two goals driving reforms targeted to raise the academic bar for students and improve the quality of teaching. The desire to raise the academic expectations for all students has led states to both adopt standards specifying what students should know and be able to do and to implement new testing mechanisms to measure what students actually know.

Although it is widely recognized that education reforms cannot be successful without actively engaging teachers, comprehensive, valid measures of change in teacher quality are difficult to come by, leaving us to rely on currently available data. Indicators of teacher credentials, experience, and participation in professional development activities are presented, as well as data on how new teachers are being inducted into the profession. As access to computers and the Internet becomes more widespread in schools, the focus of the chapter turns toward understanding how IT is being implemented and how students are benefiting from its use. In conclusion, the adequacy of student preparation for higher education is examined as a lead into the discussion of college-level S&E in chapter 2.

This chapter emphasizes variation in both access to education resources (by school poverty level and minority concentration) and performance (by sex, race/ethnicity, and family background) as data availability allows. A distinction is also made between mathematics and science when the policy implications of data are different or the data tell different stories.

How Well Do Our Students Perform in Mathematics and Science?

U.S. and internationally comparable achievement data result in a mixed report card for the United States. Although performance on assessments of mathematics and science achievement by the National Assessment of Educational Progress (NAEP) has improved since the 1970s, few students are attaining levels deemed Proficient or Advanced by a national panel of experts, and the performance of U.S. students continues to rank substantially below that of students in a number of other, mostly Asian, countries. This cross-national achievement gap appears to widen as students progress through school. This section describes progress in student performance, both long-term trends based on NAEP curricular frameworks developed in the late 1960s and more recent trends that track performance across items aligned with more current standards. International comparisons are then used to benchmark U.S. performance in these subjects.

Long-Term Trends in Math and Science Performance

Generally, mathematics and science performance on the NAEP long-term trend assessment declined in the 1970s, increased during the 1980s and early 1990s, and has remained mostly stable since that time. (See sidebar, "The NAEP Trends Study.") NAEP mathematics achievement increased among 9-, 13-, and 17-year-old students since the early 1980s, although most of these gains occurred before 1992. (See figure 1-1.) Although the average scale scores of 17-year-olds declined by 6 points between 1973 and 1982, scores increased by 9 points between 1982 and 1992 and remained at about the same level through 1999 (National Center for Education Statistics (NCES) 2000e). These gains since 1982 were substantial, equating to about a quarter of the difference between the mathematics scores of 13- and 17-year-olds (an 8-point difference is roughly equivalent to a year of schooling between these ages). Substantial gains were also made by 9- and 13-year-olds between 1982 and 1999: 8 and 13 points, respectively.

NAEP science performance over the past three decades has generally mirrored that of math: scores declined during the 1970s but increased in the 1980s and early 1990s. Because the first science assessments occurred before the first math assessments (1969 for 17-year-olds and 1970 for 13- and 9-year-olds), science achievement can be tracked over a longer period. Results for 17-year-olds show an initial 22-point decline between 1969 and 1982. In the decade between 1982 and 1992, an increase in the average score erased about half of that decline; since 1992, scores have been stable. (See figure 1-1.) Although 17-year-olds had higher science scores in 1999 than their counterparts in 1982, the average 1999 score remained 10 points below the average score in 1969. Gains since the early 1980s for 13- and 9-year-olds in science have essentially returned the average scores of these cohorts to levels similar to (for 13-year-olds) or higher than (for 9-year-olds) those posted in 1970.

A persistently wide gap in NAEP scores between low- and high-performing students remains. For example, the gap between the average mathematics scores of the highest and lowest performing quartiles for 17-year-old students was 73 points in 1999, a gap similar in size to the difference between the average scale scores for 17- and 9-year-olds in 1999 (roughly equivalent to eight years of schooling). Similar gaps have persisted for 9- and 13-year-olds as well. Efforts to apply uniformly high standards to all children need to confront the large variation in performance that currently exists in our schools.

Trends in Performance by Sex

Differences in the academic performance of female and male students on the NAEP long-term trend assessment appear as early as age 9 and persist through age 17. Although girls have consistently outperformed boys in reading and writing, gaps between the sexes in mathematics and science performance in the early grades have been much narrower and have varied over time. In 1999, 9-year-old girls had higher